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Effect of Temperature on the Thickening Time Property of Cement Slurry

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Abstract
This study was carried out using API recommended practice 13B-2 in a cement laboratory, and the essence was to establish the effect of an increase in temperature on the thickening time of cement slurry the test was carried out at different temperatures of 80°F, 100°F, 120°F, 140°F and 160°F and retarder concentrations of 0.03gal/sk, 0.07 gal/sk, and 0.10 gal/sk. The test results obtained at various concentrations and corresponding temperatures showed that there is a decrease in thickening time at 100BC as the temperature increases, at concentrations of 0.03 gal/sk, 0.07gal/sk, and 0.1gal/sk and temperature of 80°F the thickening time were 428minutes, 561minutes, and 723minutes, while at a temperature of 160°F the thickening time were 173minutes, 233minutes, and 297minutes.This, therefore, shows that temperature is a major factor in the slurry design and it has a significant effect on the thickening time of cement slurry.

Keywords: *Thickening time, Temperature, Retarder*

1. Introduction

Cementing techniques involve the deployment of cement slurry on the Oilwell annulus and casing to provide proper zonal isolation. The target is to completely hinder fluids in the well from Interacting from one part to another, provide an anchor for the casing, prevent corrosion of the Casing, prevent shock loads during drilling, prevent blowouts, plug off vugular zones and for Abandonment. A key and essential part of the wellbore construction process is cementing (Lootens, 2004) The integrity of the oil well construction depends, to a large extent on the quality of cement formulation and slurry (Ridha et al., 2010) and this is to ensure the safety of the well and durability (Pourafshary et al., 2009; Ershadi et al., 2011). The incomplete isolation of the zone has been linked to the alteration of the production capacity and efficiency of the oil well operation. If it is inefficient cementing, production below optimum is bound to occur (Calvert, 2006). Poor cement slurry design and poor cementing operations are key factors that can affect the performance of the well efficiency and could result in a reduction in oil production. Environmental damage from oil spillage is the side effect of poor cementing and poor slurry design (Lootens, 2004) that causes death to aquatic lives and land pollution causing low production of agricultural produce, making the environment inhabitable to human and animal life as it causes some respiratory diseases. The spills also result in the loss of oil that is a part of the useful global oil reserve. Temperatures are a key factor of cement slurry formulation. Well cement experience different pressure ranges downhole from pressures within atmospheric pressure to higher pressures of about 1360 kPa in wells over 10000 ft (Joel, 2009). Apart from high temperature and pressure encountered in wells, the slurries are formulated to take care of the weak or vugular formations and reactive fluids. Successes achieved in the formulation of slurry have been linked to researches, discoveries and finding from additives applies for various conditions experienced during cementation operations. Additives add in the adjustment of the slurry system, making it more efficient for obtaining the objective of successfully separating the formation from the casing to ensure that proper zonal separation is obtained during production. To achieve high-quality slurry for a good cementation operation an additive known as retarder is usually added in the slurry system to delay the time the cement sets to allow adequate time for the operation to come to an end.

Cementing operations are carried out at high-temperatures and high pressures (HTHP) in wells and this can be quite challenging and this requires cement formulations that are good technically. This study is therefore focused on the effect of temperature on the thickening time.

2. Materials and Methodology

A series of tests were performed at different concentrations and temperatures to evaluate the effect of temperature on the thickening time of cement slurry. All tests were conducted in line with the specification for materials and testing for Well Cements (Anon,1997 and 2013).

2.1. Slurry Preparation

The slurries were prepared according to the API specification 10A standard, and the thickening time test was carried out at the various concentrations and Temperature.

2.2. Thickening Time Test

The thickening time test indicates how long the cement slurry will remain in a fluid state before it hardens or becomes unpumpable (Akin et al, 2013). In order words, the duration after initial mixing when the cement can no longer be pumped (Salam et al, 2013). Consistency of cement slurry is expressed in Bearden units of consistency (Bc). The Thickening Time (TT) test was performed using a High-Pressure- High-Temperature (HPHT) Consistometer rated at a pressure of up to 206.8 MPa (30 000 psi) and temperatures of up to 204 °C (400°F). The cement slurry was mixed according to API procedures and then placed in a slurry cup into the consistometer for testing. The testing pressure and temperature were controlled to simulate the conditions the slurry will encounter in the well. The test concluded when the slurry reached a consistency considered unpumpable in the well. The time it takes the cement slurries to reach 40Bc, 70Bc and 100Bc consistency were recorded (Anon,1997 and 2013). The test was done at 80°F, 100°F, 120°F, 140° F and 160°F.

3. Result and Discussion

The thickening time results were plotted versus the retarder concentration as shown in Figure 1 to 3

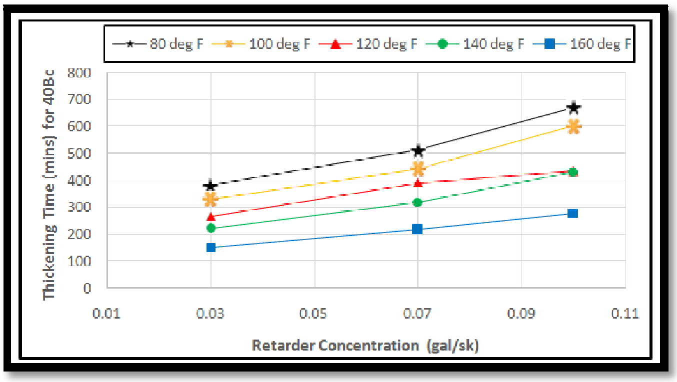

Figure 1: The Effect of Temperature on the Thickening time at 40Bc

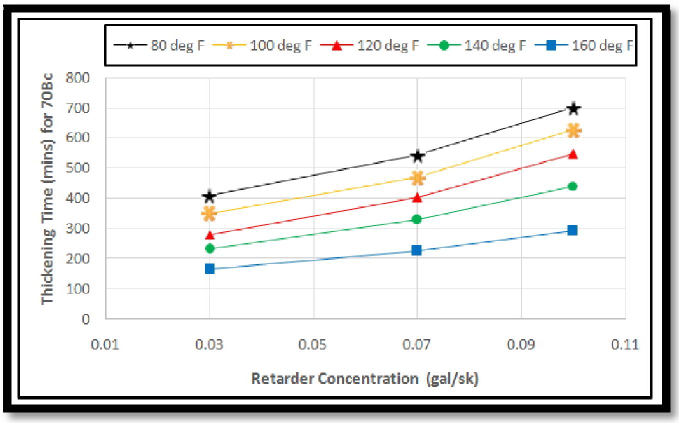

Figure 2: The Effect of Temperature on the Thickening Time at 70Bc

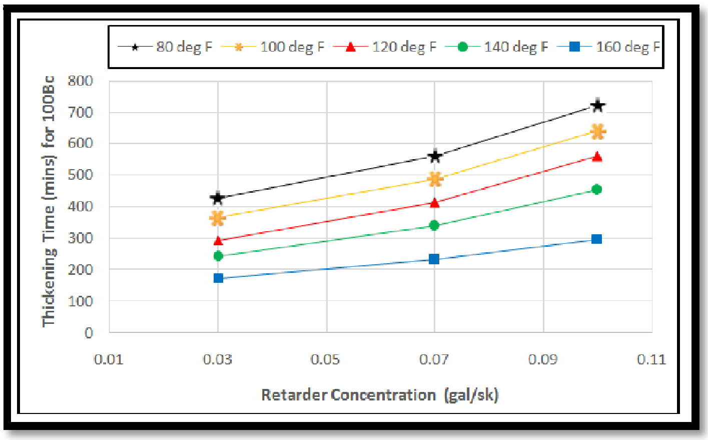

Figure 3: The Effect of Temperature on the Thickening Time at 100Bc

4. Discussion

It is deduced as shown in Figure 1 to 3 that as the temperature of the well increases, the thickening time reduces for a particular retarder concentration. It was observed that as the concentration of the retarder increases from 0.03gal/sk to 0.10gal/sk at 80^oF, the thickening time increases for 40 Bc, 70 Bc, and 100 Bc, as shown in Figure 1, 2 and 3. From Figure 3, at 100 Bc the thickening time at 0.03gal/sk, 0.07gal/sk and 0.1gal/sk were 428 minutes, 561 minutes and 723 minutes respectively, This therefore shows that at constant temperature, increase in retarder concentration causes increase in the thickening time. Further observations were made from Figure 3, at retarder concentration of 0.03gal/sk, and temperature of 80^oF, 100^oF, 120^oF, 140^oF and 160^oF the thickening time were 428minutes, 365minutes, 294minutes, 242minutes and 180 minutes respectively. This shows that at constant concentration, increase in temperature leads to decrease in the thickening time.

5. Conclusion

The test results show the following:

- That increase in temperature of the well leads to the faster setting of the cement slurry or decrease in the thickening time.
- That increase in retarder concentration delays the setting time of the cement slurry or increases the thickening time of the cement slurry

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